DOCUMENT RESUME

ED 032 072 JC 690 336

By-Boggs, John R.

A Developmental Research Plan for Junior College Remedial Education: Number 3: Concept Formation.

California Univ., Los Angeles. ERIC Clearinghouse for Junior Coll. Information.

Report No-Topical Pap-7

Pub Date Aug 69

Note-18p.

EDRS Price MF-$0.25 HC-$1.00

Descriptors-*Concept Teaching, *Institutional Research, *Junior Colleges, *Remedial Instruction, *Statistical Analysis

The remedial student's lack of success is characterized by low grades in English and math and by a high dropout rate. Topical Papers 1 and 2 (ED 022 479 and ED 026 050) considered two possible reasons for his lack of success. This paper examines a third, namely, his inability to form new concepts. It presents a description of concept learning to provide the instructor with a framework and terms for teaching a concept and an evaluation procedure for determining their effectiveness. Theories of how one forms a concept take one of two approaches: the learner as passive recipient or as active participant. In the latter case, the student has a concept when he groups things into a category according to a rule, e.g., "walk" and "talk" are verbs because they denote action. This paper provides ten questions for diagnosing erroneous concepts and a procedure for determining whether concept learning is facilitated by using a framework. Construction, application, and evaluation of the test are described. Where results are significant, they support the use of the framework; where they are not significant, they suggest further modification of the instruction methods or modification of some other factor. The test can be used for other groups of students besides remedial ones. (HH)

ED032072

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

A DEVELOPMENTAL RESEARCH PLAN

FOR JUNIOR COLLEGE REMEDIAL EDUCATION

Number 3: Concept Formation

John R. Boggs
Program Associate

Regional Education Laboratory
for the Carolinas and Virginia

ERIC Clearinghouse for Junior Colleges

Graduate School of Education and the University Library
University of California
Los Angeles, 90024

Topical Paper No. 7
August 1969

JC 690 336

UNIVERSITY OF CALIF.
LOS ANGELES

SEP 25 1969

CLEARINGHOUSE FOR
JUNIOR COLLEGE
INFORMATION

This Topical Paper was prepared pursuant to a contract with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under government sponsorship are encouraged to express freely their judgment in professional and technical matters. Points of view or opinions do not, therefore, necessarily represent official Office of Education position or policy.

TOPICAL PAPERS

1) A Developmental Research Plan for Junior College Remedial Education, July 1968.

2) A Developmental Research Plan for Junior College Remedial Education
Number 2: Attitude Assessment, November 1968.

3) Student Activism and the Junior College Administrator: Judicial Guidelines, December 1968.

4) Students As Teachers, January 1969.

5) Is Anyone Learning to Write?, February 1969.

6) Is It Really a Better Technique?, March 1969.

7) A Developmental Research Plan for Junior College Remedial Education
Number 3: Concept Formation, August 1969.

A DEVELOPMENTAL RESEARCH PLAN

FOR JUNIOR COLLEGE REMEDIAL EDUCATION

Number 3: Concept Formation

Statement of the Problem

The junior college problem that is the target for this Topical Paper is the remedial student's lack of success. His lack of success is characterized by low grades in remedial English and mathematics classes and by high drop-out rates (7).

Topical Papers 1 and 2, directed toward the same problem, considered student motivation and attitude as partial explanations for the problem. This Paper considers a third possible explanation or assumption: remedial students are deficient in their ability to learn or form new concepts.

Objectives

Toward the eventual goal of modifying remedial instruction, the Paper has two objectives. The first is to present a description of concept learning that will assist instructors when planning how to teach a concept and when diagnosing ineffective instruction. In other words, the purpose of the description is to provide a framework and terms with which to work when considering concept learning. The second objective is to provide an evaluation procedure to determine if more students are learning more concepts after instructional changes are made in accord with the framework.

The Importance of Concept Formation

Much emphasis is given to the importance of concept learning and the

prerequisite behavior of categorizing things in the world. Bruner (4:2) states: "The learning and utilization of categories represents one of the most elementary and general forms of cognition by which man adjusts to his environment." He goes on to point out that categorizing is involved in judgment, memory, problem solving, inventive thinking, and esthetics (4:4).

Concept learning is also considered intrinsic to man's ability to deal with the abstract. According to Gagné (5:47), "Learning a concept means learning to respond to stimuli in terms of abstracted properties like 'color,' 'shape,' 'positive,' 'number,' as opposed to concrete physical properties...."

In an objective study staged in a school setting, Tagatz, et al., (9:79) concluded that "success in concept attainment tasks is related to success in curricular areas." Such emphasis definitely dictates an obligation to education, described by Glaser (6:3) as follows:

> One of the functions of education and of school learning is to transmit relatively definitive meanings of certain concepts, and at the same time transmit the ability to amend and revise concepts, as well as the ability to recognize instances of experience into newly discovered or personally held concepts.

A Description of Concept Formation

The various descriptions and theories of how one forms a concept can be divided into two groups (3:24). One group considers the person obtaining the concept as a passive recipient. As a passive recipient, one would learn to say "table" when presented with a thing with the relevant characteristics (e.g., a flat surface supported by four legs) because of previous positive and negative reinforcement. With positive reinforcement, one learns to say "table" instead of "chair," "desk," etc. The second

group of theories and descriptions of concept formation considers the person obtaining the concept as an active participant. As an active participant, the individual tries to learn when a thing is a table by testing his notions or ideas. For example, an individual might hypothesize that anything with four legs is a "table." Discovering that he is wrong, the individual might then hypothesize that anything with four legs is a "table" if nobody sits on it. Bruner's description of concept formation (4) is an example of the latter group wherein the individual is considered an active participant.

Bruner's description is presented in part by answering the two following questions:

(1) When does a student have a concept?
(2) What conditions effect concept attainment?

A student has a concept when he has grouped two or more things into one category by using a rule. For example, "talk" and "walk" may be grouped into a verb category by using the following rule: If a thing is a word and denotes movement, it is a verb. Of course, students often have erroneous concepts. In the present case, the student might not categorize the word "think" as a verb because "think" does not denote movement. Reasons for erroneous concepts are varied, and their diagnosis requires considerable thought. With each of the possible reasons given below, there is also an appropriate diagnostic question.

Some questions assume that the student has one or more concepts for dealing with the task at hand. Often this assumption is not true, as shown when the student cannot provide an example.

1. Is the student categorizing things on the basis of similarity or on the basis of how the things can be used?

Often things that are distinctly different may serve the same purpose. If a student is trying to connect two parts of a sentence, he may consider only punctuation marks and not words or additional phrases. In chemistry, the concept "acid" requires the grouping of similar things; the concept "catalyst," dissimilar things. If a student has a few things categorized for a concept that entails dissimilar things, the concept is incomplete. The student needs to learn that the basis for categorizing is not similarity.

2. Is the student attending to, taking into consideration, the appropriate attributes or characteristics when categorizing?

Even the simplest object is hopelessly complex if all its attributes are considered. To minimize complexity and the need to identify each object, only certain attributes are used for categorizing. If the student is not aware of the appropriate attributes, the defining attributes, his categorization will be in error. For example, a student is often wrong if he attends to the length of words for categorizing prepositions.

3. Are the ranges of the defining attributes known by the student?

Sometimes the presence or absence of an attribute or quality provides enough information to allow for categorizing (e.g., married or not married). Other times, attributes vary in value, and different ranges indicate alternative categories. As an example, angles are categorized as acute or obtuse, depending on the number of degrees between the intersecting lines. A student who does not know the related ranges may consider only very sharp angles as acute. When the number of distinctions that depend upon different values of the same attribute increases, the difficulty

of accurately categorizing also increases.

4. Is the student confused by noisy attributes?

This question is similar to Number two, since it suggests the appropriate attributes, but it differs by calling attention to a common reason for not attending to the appropriate attributes. Students are often misled by noisy attributes*, those that change from one example to another of the same concept. (In this terminology, noisy does not imply sound, although sound could be a noisy attribute.) For example, the octopus is often not considered to be a mollusk because it lacks a noticeable shell. In this case, the student is misled and does not categorize the octopus with clams and snails because of at least one noisy difference--shell versus no shell.

5. In terms of student experience, how immediate are the defining attributes?

Concrete or perceptual concepts involve categorization based on attributes that are immediately experienced. Abstract concepts, on the other hand, involve categorization based on attributes that are not immediately experienced. For comparison, consider the concepts "rock" and "justice." For a correct concept, it is important that the student understand the abstractness of the concept and how to attend to (or experience) the appropriate attributes. In the case of "justice," the student must deal with such abstractions as impartial consideration and merited rewards

---

*Bruner (4:48) defines a noisy attribute as "any attribute whose testing distracts or delays the discovery of a set of defining attributes."

or punishments.

6. Does the student need to consider many attributes?

Often correct categorization is complex and difficult because the student must attend to many attributes. In such cases, he needs a plan or procedure for approaching the problem of categorization. For example, consider the concept "logical." While complete courses are designed to enable students to determine if a statement or decision is logical, even without a course, they will have some facility with a few criteria of validity and principles of reasoning. Laboratory procedures used by students to categorize plants, animals, chemical substances, etc. are examples of how to deal with many attributes.

7. Is the student using the correct rule for categorizing?

Since a student has a concept when he groups two or more things into one category by using a rule, the rule might be the key factor when diagnosing an erroneous concept. Three types of rules are used: (1) conjunctive, (2) disjunctive, and (3) relational. Each rule refers to a different way of considering attributes in order to determine if a given thing is an example of a given concept.

When the joint presence of two or more attributes (or appropriate values of the attributes) is required for a thing to be an example of a concept, the concept is a conjunctive concept. For instance, if a student requires the presence of both a trunk and limbs for a thing to be an example of a tree, he is using a conjunctive rule.

When attributes substitute for one another, the concept is disjunctive. Disjunctive concepts are the most troublesome and should probably

receive extra instructional time and effort. Often there is no apparent relationship between the different attributes present in one example and another of a disjunctive concept. Such concepts as "immoral behavior," "love," and "neurotic" are disjunctive. In the case of "neurotic," excessive laughter may or may not be an attribute. The same may be said of other attributes: crying, depression, lying, etc. If a student is applying a conjunctive rule when dealing with a disjunctive concept, he is often confused.

The third type of rule is the relational. It requires a specific relationship between the defining attributes. Two examples of a relational concept are "income tax bracket" and "density." One's income tax bracket is defined by his level of income and his number of dependents. Density is defined by the mass of a substance per unit volume. In this case, a student makes errors when he does not have the knowledge of the specific relationship.

Questions 1 through 7 center around the question: When does a student have a concept? The remaining questions pertain to the conditions that effect concept attainment.

8. How has the student defined the task?

If a student sets out to memorize each example of a concept, he is less likely to learn the rule for categorizing than if he sets out initially to learn the rule. Therefore, time as well as mental strain, is saved if the student is diverted from rote memory. Discovery learning is one approach that directs students toward the task of learning the "rule."

9. What kind of example does the student encounter while learning the

concept?

Examples should cover the entire range of instances of the concept. A few examples not representative of the entire range will lead to immature concept formation. For example, a student who has formed the concept "division problem" from mathematical examples (e.g., 9/3) might not recognize a division problem when it is presented in thought-problem form. The presence of many negative examples during concept formation (a condition that may occur during testing) causes problems for the student. In this case, the student is involved in the complicated task of memorizing all the attributes that indicate something is not an example of the concept. On the other hand, a few negative examples may cause the student to be cautious and thereby avoid premature concept formation.

10. What opportunity does the student have for validating his conclusions?

As a student learns a concept, he must decide whether each new instance is or is not an example of it. After the decision, he needs to know if he is correct or incorrect in order to determine if he should handle the next instance in the same manner--consider the same attributes or attribute values or use the same rule. If he cannot validate his decision, he has no information for further learning. This strongly supports the obvious: the student should report his decisions and receive feedback for validation. Report of decisions requires instructional time and a method that minimizes the student's concern for being wrong.

Infrequent, delayed, or ambiguous validation encourages the student to use personally preferred methods for categorizing or methods he has found useful in the past. These may not be adequate. An exception is made

for ambiguous validation. Some concepts are ambiguous by nature, and whether an instance is an example or not is probabilistic. Whether certain acts are patriotic or not is one example. Ambiguity is generally associated with inadequate or conflicting definitions. To avoid student frustration, concepts of an ambiguous nature should be characterized as such. Often a large sum of money and a long period of time are required for a court to decide if an instance is an example of a concept.

It is reasonable to assume that from time to time students do not look for validation, especially if there are affective reasons for their decision. The instructional implications for such a situation are not presently considered.

The ten questions above are designed for diagnosing erroneous concepts. Rewording the questions draws attention to important points to consider when designing instruction for teaching new concepts:

1. What is the basis for categorization--similarity, or common usage?
2. What are the defining attributes--those that should be considered for accurately identifying examples of the concept?
3. What are the ranges of the defining attributes?
4. What are the noisy attributes?
5. How abstract are the concept and related attributes?
6. What plan or procedure is useful for categorizing examples of the concept?
7. What are the three rules for categorizing?
8. How can the instructional procedure direct the student toward the rule and away from rote memory?
9. What examples should be used for instruction?

10. How can the instructional procedure provide for appropriate validating experiences?

The above framework can be used as a guideline for teaching new concepts and can also serve as instructional material. The related assumption is that students with a framework for dealing with concepts will have greater facility for comprehension when confronted with a concept learning task than those without the framework.

Evaluation Procedure

Three uses for the description of concept formation have been mentioned: (1) to diagnose erroneous concepts, (2) to modify instruction for concept learning, and (3) to provide students with a framework for concept learning and self-diagnosis. Regarding the last two in particular, the major concern is whether or not concept learning is facilitated by using the framework. The present evaluation procedure is designed to answer this question: Do more students learn more concepts if the framework is employed?

The evaluation procedure requires two groups of students, a list of concepts, a test to measure concept attainment, and a statistical test.

Student Groups

One group of students (Group I) is to receive the standard on-going instruction. Group II is to receive instruction that has been modified on the basis of the framework or of its presentation or both. There should be at least ten students in each group, and the range of student ability in both groups should be comparable. There is no limit on the size of the groups, and the sizes need not be equal. Groups may be drawn from classes from successive semesters or from two or more classes during one semester.

Any number of instructors who teach the same course may participate in the evaluation.

There are two methods for selecting group members. The first is to assign students randomly to the classes involved. The second is to match students on the basis of ability (e.g., GPA or test scores). If matching occurs after the classes are formed, there may be occasion to disregard some students during the data processing phase of the evaluation. Which students to include is decided before evaluation starts.

Concept Selection

Depending on the course, relevant concepts are selected; the present procedure is designed for six to 25. Instructional plans and strategies for teaching each concept are deduced by considering the ten questions listed above. All questions are not necessarily relevant to all the selected concepts. Concepts need not be similar and their range of difficulty is not limited for the evaluation procedure.

Concept Attainment Test

Both groups receive the same test, which must be designed to allow the instructor to categorize each student as knowing or not knowing each concept. The present procedure does not allow for partial grasp of a concept. Multiple choices and free-response tests are two possibilities. The latter would require the student to produce an example of the concept. The multiple-choice test has two advantages: first, scoring and categorizing the students as knowing or not knowing the concept are easier; second, alternative responses in a multiple-choice test could be designed to answer

diagnostic questions concerning erroneous concepts. For example, if a student picked the wrong alternative, it could indicate that he was not aware of a defining attribute.

Statistical Test

After both groups finish the concept attainment test, the percentage of students knowing each concept is calculated for each group. For example, if there are 60 students in Group I, of whom 40 know a concept, the percentage is 40/60 x 100 or 66.

Table I gives sample data for eleven concepts:

TABLE I

Percentage of Students
Who Know the Concept

Concept	Group I	Group II	Difference
1	66	75	9
2	49	63	14
3	35	32	-3
4	57	57	0
5	30	47	17
6	71	66	-5
7	82	88	6
8	51	63	12
9	62	54	-8
10	73	82	9
11	46	67	21

After the percentages are listed, the difference between the groups for each concept is determined by subtracting the percentage for Group I from that for Group II. These differences are used for the statistical test (the Wilcoxon matched-pairs signed-ranks test), which is easily applied (8:75).

The test is applied to provide a method for making a decision on the basis of the data. The decision is whether or not there is a significant effect, in terms of student learning, when instruction for teaching concepts is modified on the basis of the present framework or description of concept formation. A T value is used to determine if there is a significant effect.

Two steps are required for calculating T. First the differences are ranked, the value 1 being assigned to the smallest difference. Following is an example using the sample data from Table I:

Concept	Difference	Rank
1	9	5.5
2	14	8
3	-3	1
4	0	(omitted)
5	17	9
6	-5	2
7	6	3
8	12	7
9	-8	4
10	9	5.5
11	21	10

When ranking, the sign of the difference is disregarded. For example, the -3 for concept Number 3 is considered smaller than the -5 for concept 6. Zero differences are omitted and do not receive a rank. If two or more differences are equal (1 and 10 in sample data), they receive the same rank. This rank is the mean of the ranks that would have been assigned if the differences were not equal. In the example, concepts 1 and 10 would have received ranks 5 and 6. Since they are equal, each receives the rank of 5.5, the mean of 5 and 6.

The second step is to add the ranks that are associated with negative differences. In the present example, ranks for concepts 3, 6, and 9 are added:

Concept	Rank
3	1
6	2
9	4
	7

This sum, 7, is the T value.

The T value and Table II are used to decide if the results are significant.

TABLE II

T Values Needed for Significant Results[1]

Number of Concepts	T Value[2]	Number of Concepts	T Value
6	0	16	30
7	2	17	35
8	4	18	40
9	6	19	46
10	8	20	52
11	11	21	59
12	14	22	66
13	17	23	73
14	21	24	81
15	25	25	89

1. (8:254)
2. Values are for a two-tailed test and the .05 level of significance.

To use Table II, first subtract the number of zeros, if any, from the number of concepts listed in the data. One zero and 11 concepts are found in Table I; therefore, the number 10 is relevant for the present example. This number is then found in the "Number of Concepts" column in Table II.

After the table is entered, the corresponding T value is compared with the T value calculated. If the calculated T value is equal to or less than the T value found in Table II, the results are significant. Results are significant in the sample case; 7 is less than 8.

Significant results support the use of the framework for modifying instruction, but one should be cautious and consider other possible explanations (e.g. different instructors) when interpreting the results. Results that are not significant suggest that further instructional modifications are needed or that modifications should be made on some other basis.

Summary

This Paper presents, in part, a description of concept formation, to give direction for modifying instruction for teaching concepts. It also presents a procedure for evaluating the modifications. Although the Paper's emphasis is on the remedial student, it is applicable to other student groups. The emphasis follows from the assumption that one reason for the remedial student's lack of academic success is a deficiency in ability to learn or form new concepts.

REFERENCES

1. Boggs, John R. A Developmental Research Plan for Junior College Remedial Education. Los Angeles: ERIC Clearinghouse for Junior Colleges, 1968.

2. Boggs, John R. and Herrscher, Barton R. A Developmental Research Plan for Junior College Remedial Education, Number 2: Attitude Assessment. Los Angeles: ERIC Clearinghouse for Junior Colleges, November 1968.

3. Bourne, Lyle E., Jr. Human Conceptual Behavior. Boston: Allyn and Bacon, Inc., 1966.

4. Bruner, J. S., Goodnow, J. J., and Austin, G. A. A Study of Thinking. New York: Wiley, 1956.

5. Gagné, Robert M. The Conditions of Learning. New York: Holt, Rinehart and Winston, Inc., 1965.

6. Glaser, Robert. Concept Learning and Concept Teaching. University of Pittsburgh: Learning Research and Development Center, 1967.

7. Roueche, John E. Salvage, Redirection, or Custody? Remedial Education in the Community Junior College. Washington, D. C.: American Association of Junior Colleges, 1968.

8. Siegel, Sidney. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill Book Company, 1956.

9. Tagatz, Glenn E., Lemke, Elmer A., and Meinke, Dean L. The Relationship Between Learning Concepts and Student Achievement. Cooperative Research Project No. 5-493. Indiana State University: School of Education, 1966.